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XXVI.—*The Ostracoda and Foraminifera of Tidal Rivers.* By GEORGE STEWARDSON BRADY, C.M.Z.S., and DAVID ROBERTSON, F.G.S. *With an Analysis and Descriptions of the Foraminifera,* by HENRY B. BRADY, F.L.S.

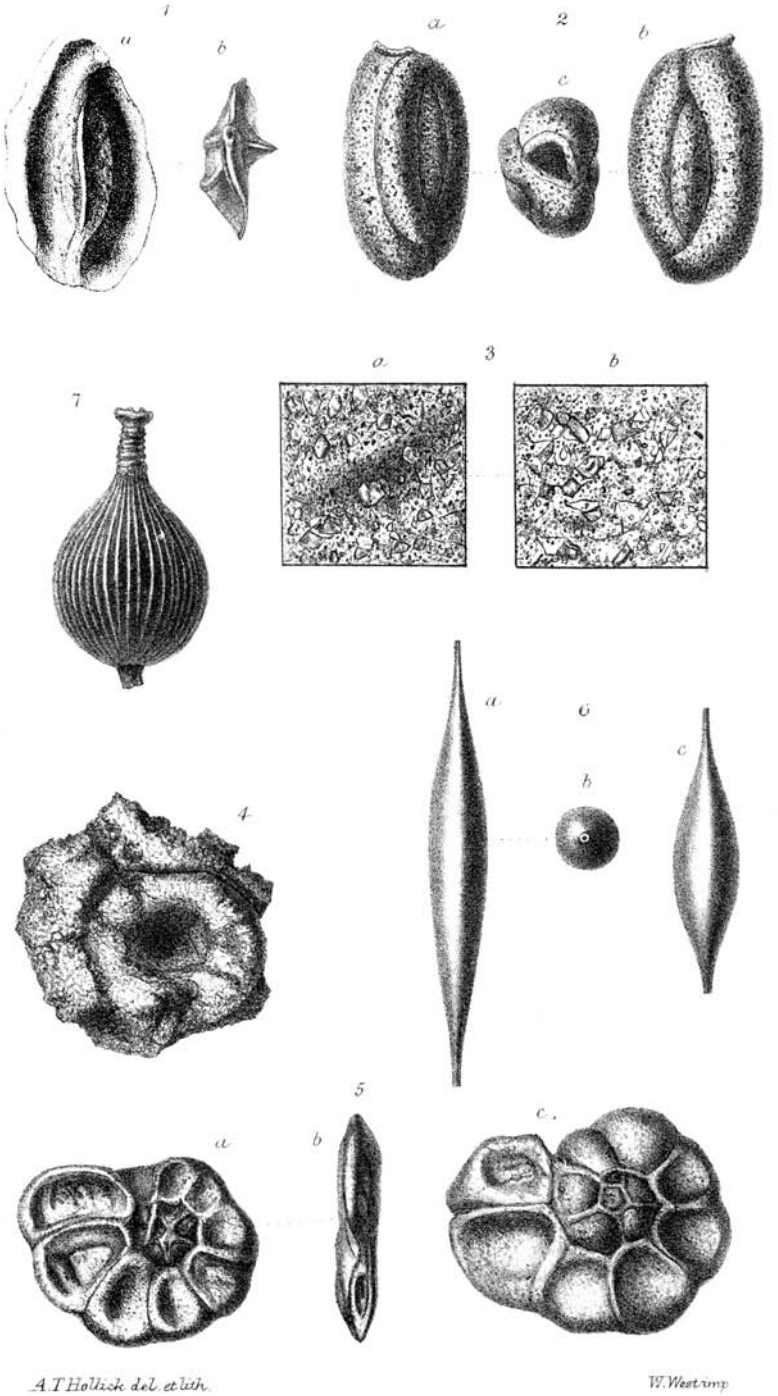
[Plates XI. & XII.]

Part II.

THE Rhizopoda inhabiting brackish water are interesting alike in their zoological and physiological aspects. The marine species belonging to these lower types of animal life are well known so far as concerns the British seas, and their mutual relationships have been thoroughly studied; the freshwater fauna of corresponding organization has also received careful attention at the hands of able naturalists; but researches on the two subjects have been prosecuted in a great measure without reference to each other, and our knowledge of the intermediate fauna is consequently fragmentary and of limited value for purposes of comparison.

The results detailed in the present paper have no claim to be regarded as an exhaustive treatment of the subject, but are offered rather as another instalment towards the history of an interesting phase of animal existence.

The structure of the investment of the sarcode body of the Rhizopoda, and its chemical and physical characters, have been regarded as forming the most reliable basis for classification; but how much the nature of the carapace depends upon mere external circumstances has already been shown, with respect to the Difflugian group, by Dr. Wallich; and there can be little doubt the same views are equally applicable to some genera of the order Reticularia. Hence a few preliminary remarks may not inaptly be devoted to general consider-



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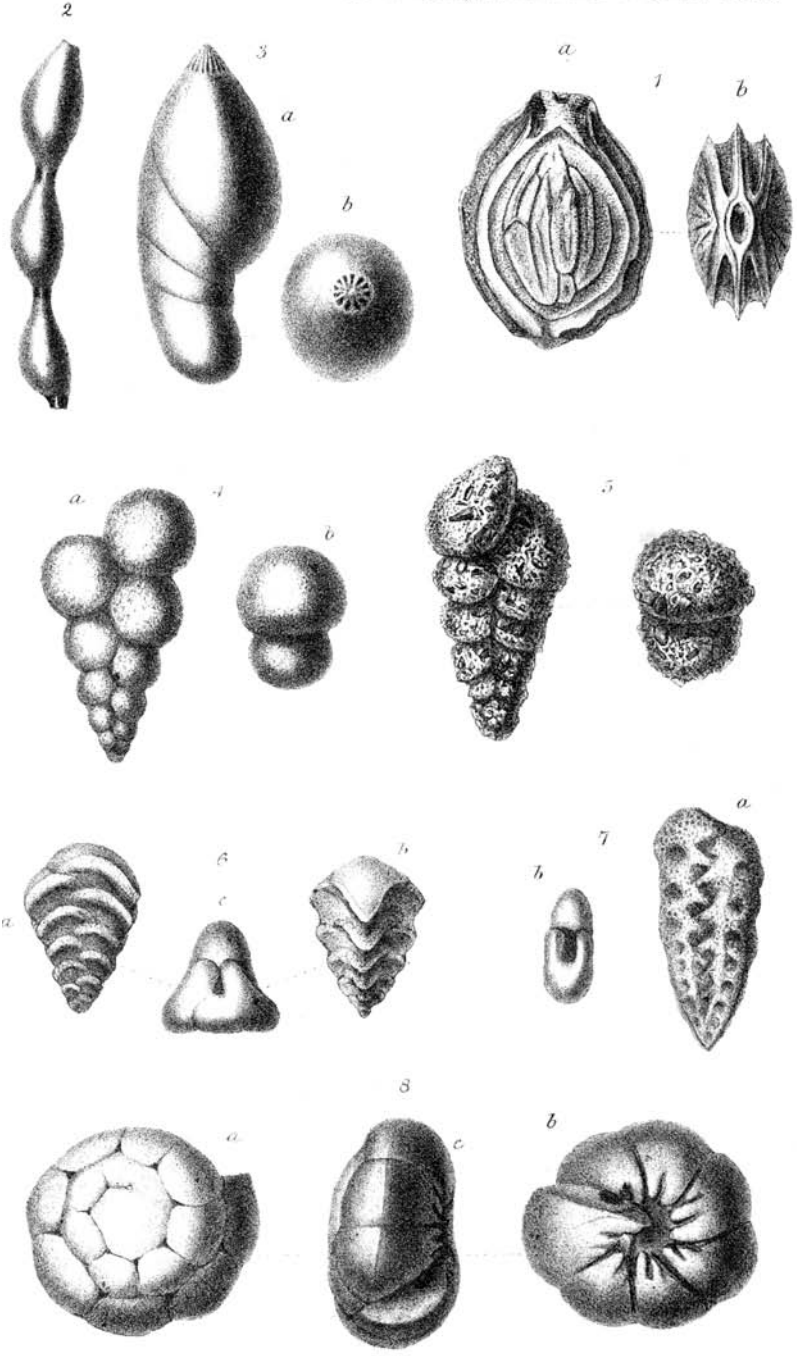

ations respecting the relation of the marine Rhizopod fauna of our coast to that of its adjacent brackish waters, first, with respect to distribution, and, secondly, with regard to modifications in the external characters of species common to both, due to altered conditions of life.

A comparison of the Table of Brackish Foraminifera with the complete list of species known to inhabit the British seas will show that the number of types or subtypes that entirely refuse to accommodate themselves to brackish conditions in one or more of their varietal developments is exceedingly small. Out of the forty-four reputed genera constituting the British marine fauna, representatives of thirty-two appear in the table, the following only being absent, viz.:—*Hauerina*, *Saccammina*, *Valvulina*, *Lingulina*, *Spirillina*, *Bigenerina*, *Cassidulina*, *Anomalina*, *Tinoporus*, *Nubecularia*, *Operculina*, and *Nummulina*. Specimens closely resembling *Saccammina* and *Tinoporus* have been noticed in our brackish gatherings; but, as their identification is not beyond dispute, they have been excluded from the list. *Hauerina*, *Lingulina*, and *Nubecularia** are of extreme rarity in our seas; the occurrence of living specimens of *Nummulina* is still ground of debate; and the remaining six genera are either somewhat local in their distribution or affect our deeper waters only. It should be noted that *Glandulina* has no claim to a place in the Table, except on the ground of a solitary specimen from the Scheldt.

Passing from entirely absent types to those whose presence may be regarded as accidental (such as are represented by one or two examples only, usually of stunted growth and confined to a single locality), seven other genera may be set aside as not "proper" to brackish water, viz. *Nodosaria*, *Vaginulina*, *Marginulina*, *Uvigerina*, *Orbulina*, *Virgulina*, and *Pulvinulina*. As the two first named are very common indeed on many portions of the coast at no great distance from brackish areas which have been searched, their non-appearance can only be explained on the ground that they do not survive any material decrease in the proportion of saline constituents in their native element; and this is doubtless true of all seven.

Cornuspira, *Cristellaria*, *Polymorphina*, *Globigerina*, *Textularia*, and *Patellina* show greater adaptive power; but the invariable smallness and delicacy of their shells, and their presence in those localities only which are least removed from the direct influence of the sea, indicate that, though still surviving, the admixture of even small proportions of fresh water

* *Nubecularia* has not hitherto been recorded from a British locality; but I have specimens of *N. lucifuga* from deep water in Mounts Bay, Cornwall.—H. B. B.

has an essentially deteriorating influence. The same remark is nearly equally true of the Textularian genera. On the other hand, the genus *Lagena* occurs in great abundance and variety amongst the microzoa of the less brackish gatherings, especially in those taken from muddy bottoms, though never found where the influx of fresh water is excessive. The specimens are of average size, fully developed, and have well-marked characters; indeed the genus appears to flourish in such situations. *Bulimina*, represented almost exclusively by *B. ovata*, *Planorbulina*, by *P. mediterranensis*, and *Discorbina*, by *D. globularis* and *D. rosacea*, are also common under similar conditions.

Lastly, we find a number of genera which flourish in water of varying degrees of density, from that of the more nearly marine localities to which allusion has just been made, to that of pools which at times contain only traces of saline matter. The most conspicuous are the Milioline genera (notably *Quinqueloculina*), *Trochammina*, *Lituola*, *Truncatulina*, *Rotalia*, *Polystomella*, and *Nonionina*. These genera are usually associated under such circumstances with Rhizopoda of the Difflugian type—the latter increasing in number as the Foraminifera diminish, until, in fresh water, the *Difflugiæ* and their immediate allies become the representatives of the testaceous group.

Specimens of two species of Foraminifera (*Polystomella striatopunctata* and *Nonionina depressula*), to all appearance living and associated with other living microzoa, however, have been found in fresh water. The locality was a freshwater lough about five miles south of Westport in Ireland. These are doubtless the survivors of a prehistoric brackish fauna; and their existence is not altogether surprising when we know that in some scarcely brackish situations far removed from the sea (for instance, the upper pools in Hylton Dene) the same species are or, rather, in this case *were*, before the tract was drained, present in abundance.

The Foraminifera of the Fen area are somewhat anomalous in their distribution, and require separate notice. We have the means, rarely attainable, of comparing them with their immediate predecessors in point of time. In many parts of the district there is to be found immediately underlying the peat a bed of clay which, at some distant period (scarcely distant enough to rank in geological time), formed the muddy bottom of the brackish or almost marine expanse of water. The microzoa of this subrecent deposit have been thoroughly investigated by Messrs. Parker and Jones; and the results, collected from four different localities, are tabulated in an elaborate memoir, published a few years ago in the 'Philosophical

Transactions' (vol. clv. p. 422). These go far to explain the peculiarities of the living fauna of the same area. In most of our brackish localities the living species are presumably the offspring of specimens which have been washed in and gradually acclimatized; but in the Fens the present Rhizopod fauna must consist in great measure of the direct representatives of those which flourished under the earlier more nearly marine conditions; and hence, with some allowance for possible change of climate, the relation of the living to the subrecent fauna is one which has been determined by gradual alteration in the physical aspects of the country, of which the chief result, so far as affects animal life, has been the lessened proportion of saline constituents in the water. The following genera, which were living in the Fens at this earlier era, have now totally disappeared, viz.:—*Cornuspira*, *Nodosaria*, *Uvigerina*, *Spirillina*, *Textularia*, *Virgulina*, *Bolivina*, *Pulvinulina*, *Discorbina*, and *Patellina*; and it is a noteworthy argument against the probability of any material change in climate that the whole of these, except *Spirillina*, still live in brackish water at portions of our coast nearer the open sea than the Fens now are. On the other hand, no single new genus has appeared during the period, if we except a straggling specimen or two of *Biloculina*. The *Miliolæ* generally have become commoner, whilst the whole family of the *Lagenida* have diminished in numbers; but, with these exceptions and the disappearance of the types above enumerated, there is a striking agreement between the present and past Rhizopoda of the Fen area. Our analysis need not extend to details respecting species, which may be gathered from the Table, further than to note that, out of forty-one specific and varietal forms found subfossilized in the clay, twenty have survived the changes alluded to, and the few new forms which now exist generally represent depauperated conditions of certain of the older types.

A comparison of specimens derived from marine and brackish sources, in species common to both, has considerable bearing on the connexion between the various groups of Rhizopoda. The effect of change of habitat is more marked in some genera than in others; but it may be generally stated that as the proportion of salines in the water decreases, the tests of the Foraminifera show a corresponding deficiency in calcareous matter.

In the *Miliolida* the deficiency is sometimes evidenced merely by the diminished thickness of the shell-wall, as often seen in *Quinqueloculina subrotunda*; but it takes quite another character in the composite or almost chitinous test of *Q. fusca*.

The latter species has, in place of the normal porcellaneous shell, an investment consisting of a horny membranous basis with imbedded sand-grains partially cemented by calcareous deposit. So little is the calcareous element essential to the solidity of the test, that prolonged treatment with an acid does not materially change its form or appearance; nor, beyond slightly increasing its transparency, does it appear to produce any alteration in its minute structure. A portion of the carapace of a specimen in its natural state is represented, highly magnified, at Pl. XI. fig. 3 *a*, and a similar piece, decalcified by strong acid, is shown in fig. 3 *b*; both are from preparations mounted in Canada balsam, and viewed by transmitted light.

The *Lituolida* with variable but essentially composite tests have their best brackish representative in *Trochammina inflata*. Under similar enfeebling conditions, they show a tendency to change in the same direction. The deposit of calcareous cement is diminished, and with it the foreign matter which forms so large a proportion of the "built-up" test of marine specimens, until the animal has often only the investment of a thin, nearly smooth, chitinous membrane. The change in the structure of the test is not accompanied by any diminution in size; on the contrary, the finest specimens of *Tr. inflata* we have seen were of this membranous sort.

The chemical nature of the investment is similar to that of *Quinqueloculina fusca*. Large specimens have been treated with nitric and hydrochloric acids, and strong solution of caustic potash, without sensible change, preserving sufficient solidity and firmness to permit of being mounted in Canada balsam, at the end of the process, without fracture.

The *Lagenida* do not appear to subsist where they are unable to produce their normal hyaline shell: no examples have been met with in the gatherings furthest removed from the sea; and in the other localities they do not differ from marine specimens.

Of the *Globigerinida* only two species require comment. A chitinous spherical test, brown in colour, but otherwise very closely resembling *Orbulina universa*, is not unfrequently found in brackish pools. The occasional specimens of *Orbulina* met with in the littoral and laminarian zones are commonly thin-shelled and dark-coloured; and it has more than once occurred to us whether these brackish organisms, which have been set down as belonging to the genus *Gromia*, might be the representatives of the normally calcareous species. Such an explanation seems the more possible from the fact that small examples of *Globigerina*, a genus almost invariably

associated in deep water with *Orbulina*, are not unfrequent in our brackish gatherings.

Rotalia Beccarii exhibits modifications of somewhat different nature; but, as they are morphological rather than structural, their description may be left to a subsequent page.

The *Nummulinida*, with higher organization, present no change under brackish conditions, beyond the thinning of the shell-wall and occasional tendency to wild growth. It is at first sight singular that, whilst the feebler species *Polystomella striatopunctata* and *Nonionina depressula* are everywhere abundant in estuarian pools, not even a straggling specimen of the typical *Polystomella crispa* has ever been met with, although it is one of the commonest of our marine species. The characters of the shell afford a probable explanation: for the thickening of the shell-wall and the formation of sutural ridges and spinous processes a larger supply of mineral constituents than can be derived from brackish water may be supposed to be essential. In the two common brackish species the test becomes thinner and more delicate as the proportion of saline matter diminishes, and often assumes a pale-green colour in the grassy pools which receive land-drainage and have only occasional communication with the sea.

The importance of these facts consists chiefly in the light they seem to cast upon the relation between some of the marine and freshwater groups of Protozoa. The physical and chemical characters of the investment appear from them to be, zoologically speaking, of limited value, and are not applicable always even to the whole of the specimens within the limits of a species. It has been shown, we think, beyond doubt that varieties of a normally compact and porcellaneous type like *Miliola* may secrete a carapace as chitinous as *Gromia* itself, when living for a succession of generations under circumstances which render the supply of calcareous material insufficient for the purpose of shell-building, and that a corresponding adaptation to altered life-conditions takes place in the normally rough and cemented tests of the *Lituolida*. The probability of similar modifications in the higher groups, such as that hinted at with reference to the *Globigerinida*, need not be insisted upon. The test in *Difflugia* presents no character that we know of to distinguish it from a single-chambered *Lituola*. How far the extension of the sarcode beyond the carapace, or its subdivision in the pseudopodia, yields a more stable basis for zoological classification, assuming its organization to be equally simple in the marine and freshwater testaceous groups (of course excluding the Polycystina), is a question upon which we are not yet prepared to enter.

Some genera of Rhizopoda are regarded as calcareous or arenaceous, and proper to the sea (*Foraminifera*), others as chitinous or arenaceous, and pertaining chiefly to fresh water (*Gromia* and *Difflugia*); the evidence afforded by specimens obtained under intermediate (brackish) conditions indicates the problem, whether *gradual modification of external circumstances*, with a large allowance of *time*, may not be held to account for many characters supposed to be of generic or even ordinal importance.

The Table representing the distribution of Foraminifera differs in several important particulars from that relating to the Ostracoda (pp. 27–33), and has been compiled with the intention of including as far as possible what is known of the occurrence of this class of Rhizopoda in brackish water, rather than their relation to tidal rivers exclusively. Some of the gatherings rich in Entomostraca contained no Foraminifera; of others record was kept of Ostracoda only: hence the omission of several columns which appear in the previous table. The converse is also true; and collections of Foraminifera from several additional brackish localities have been collated, in order to render the synopsis as comprehensive as circumstances admit.

Of Group I., pertaining to river-estuaries of England and Scotland, the following columns are omitted:—D, Warn Burn; I, River Ouse at Goole; J, River Humber; K, River Deben; L, River Stour; M, River Thames; and N, Fowey Harbour. Of Groups II. & III., referring to the English Fen-district and Holland, the following are wanting:—P, Whittlesea Dyke; X, Ormesby Broad; Z, Lake Lothing; C *c*, River Ouse, Norfolk; E *e*, River Maas. It is to be regretted that the Whittlesea-Dyke gathering has been mislaid, as it contained a preponderance of Foraminifera. The material from Ormesby Broad contained a considerable number of *Difflugiæ*, but no other Rhizopoda.

In the Table of Foraminifera the *letters* heading the columns correspond with those used for the same localities in that devoted to the Ostracoda, and the additional columns are referred to by *numbers* (1 to 15). A few brief memoranda concerning the localities not previously described are necessary to complete our topographical notes.

1. *River Tay, near Errol.*—A gathering taken south of Errol, between the river and the gamekeeper's house, in soft muddy gullies and lagoons. The shore for a considerable

distance at this place is made up of reedy ground traversed by channels interspersed with pools covered by the tide at high water.

2. *Frith of Forth.*—This material was dredged in three to four fathoms, twenty yards or so from the pier at Bo'ness. It was a soft slimy mud, the water being brackish, but not strikingly so. That the Rhizopodal fauna presents a closer approximation to that of the laminarian zone than most of the localities investigated, is readily explained by the wide communication with the open sea.

3. *Seaton Sluice.*—A sort of harbour at the *débouchement* of the Seaton Burn, about six miles north of the Tyne. The Rhizopoda were all of the commoner brackish type.

4. *Jarrow Slake.*—A large muddy expanse on the south side of the estuary of the Tyne, within a couple of miles of the sea. At low water the whole tract is left exposed, except the freshwater channel of a small tributary stream (the Don), which flows through it to its junction with the river. Samples of soft mud from various points of the surface left uncovered at low tide were collected for us by our friend Mr. Drewett Drewett of Jarrow Hall. Their examination only yielded specimens of four of the commoner brackish species.

5. *Hylton Dene.*—On the north bank of the river Wear, about two miles above Sunderland*. Several gatherings were made among the grassy pools, which have only occasional communication with marine water. The water in some cases showed only one per cent. of saline constituents.

6. *Hartlepool Slake.*—A muddy expanse between Hartlepool and West Hartlepool, running inland some distance and receiving the freshwater drainage of one or two rivulets, but covered by the sea at high tide. Our gathering, which was from some old mud, probably does not represent exhaustively the Rhizopoda of the locality.

7. *River Tees near Middlesbro'.*—The wide outspread estuary of the Tees is to a great extent a muddy flat at low tide. Somewhat removed from the bed of the river, on either side, are a succession of grassy pools and ditches, all more or less brackish. The material examined was obtained from situations of this sort on the south side.

8. *River Exe, Devonshire.*—From the gravelly stony river margin near Lympston, halfway between Exeter and Exmouth, near low-water mark (an exposed situation, too much affected by the wash of the tide for minute and delicate organisms, and

* For a detailed account of the zoology of this interesting locality, see Trans. Tyneside Nat. Field-Club, vol. vi. p. 95.

presenting a correspondingly meagre fauna), a few Ostracoda were noticed of the following species:—

Cythere porcellanea, *Brady.*	Paradoxostoma Fischeri, *G. O. Sars.*
—— castanea, *G. O. Sars.*	—— hibernicum ?, *Brady.*

9. *Estuary of the Ribble.*—We are indebted to Mr. E. C. Davison for a sounding from this locality. It consisted of fine sand; and though the quantity was very small, it contained microzoa of considerable interest. The only specimen of *Uvigerina irregularis* that has been found on the west coast occurred in it.

In the *second* group, which is confined to the Fen area, no additional localities are included in the table.

The *third* group is somewhat miscellaneous, and is almost entirely new. It consists chiefly of the results of collecting on the west of Scotland. The Scheldt gathering and one from the west of Ireland are, to save further division, placed in the same set.

10 & 11. *Loch-in-Daal* and *Loch Grunard.* The former locality is the large bay facing southwards, the latter the smaller inlet opening northwards in the island of Islay. In both of these a large marshy tract extends inland, portions of which are only covered at the highest tides; and we are indebted to Mr. R. Y. Green for parcels of mud obtained from the grassy pools above the ordinary high-water marks. Though differing considerably, both gatherings are eminently brackish; that from Loch Grunard contained the only specimen of *Trochammina squamata* we have yet met with under such conditions—indeed, with the exception of rare examples from deeper water among the Hebrides, the only one hitherto found on the British coast.

12. *Portree Harbour, Isle of Skye.*—Sandy mud obtained near the point where a small stream empties itself into the sea, a little above high-water mark. For this material we are indebted to Mr. Joseph Wright, of the Newcastle Museum.

13. *Loch Gilp.*—A gathering procured from a small burn at a point only reached by the sea for a short time at high water. The bottom was mud and small gravel, deeply coloured with ferruginous deposit. The number of species very limited.

14. *Westport, Ireland.*—From a brackish pond subject to the tide, but never left dry; depth, two to three fathoms; bottom, sandy gravel; the water in some degree brackish, from the influx of a small stream. The fauna indicates more nearly marine conditions than most of those included in the Table, and is remarkable from containing specimens of *Ver-*

neuilina spinulosa—its first recorded occurrence on the British coast.

15. In a separate division a summary of the results of Messrs. Parker and Jones's researches on the Foraminifera of the clay underlying the peat in the Fen district is given, in order to facilitate the comparison of the prehistoric fauna of this interesting area with that at present existing. It is compiled from four columns in their "Table of the North-Atlantic and Arctic Foraminifera, with their Distribution in other Seas" (Phil. Trans. vol. clv. p. 422, table vii.), headed respectively as follows:—

"1. *Subrecent. Peterborough Fen, one mile from its western boundary* (*sandy clay*).
"2. *Subrecent. Peterborough Fen, two miles from its western boundary* (*sandy clay*).
"3. *Subrecent* (*clay*). *Boston, Lincolnshire.*
"4. *Subrecent* (*clay*). *Wisbeach, Cambridgeshire* (*Valley of the Nene*)."

Setting aside the last column, which need not affect general considerations, the groups into which the Table is divided have a purely geographical basis. Reference to physical conditions, such as depth, proportionate admixture of fresh water, proximity to the open sea, and the nature of the bottom, would give a somewhat different classification, and one bearing more closely upon zoological relations.

So divided, a first series would embrace those localities in which, either owing to wide and easy communication with the ocean or a relatively small influx of fresh water, the Rhizopod fauna approximates in some degree to that of the littoral and laminarian zones. Seven of the columns might be comprised under this head, viz.:—B, Montrose Basin; C, Budle Bay; E, River Aln; G, River Wansbeck; H, River Blyth; 2, Frith of Forth; and, 14, Westport, Ireland. Columns 9, River Ribble, and D *d*, River Scheldt, probably belong to the same series; but a deficiency of material for examination leaves some uncertainty with respect to them. The presence of *Quinqueloculina fusca*, *Trochammina inflata*, and *Rotalia Beccarii*, and the abundance of *Polystomella striatopunctata* and *Nonionina depressula*, may be accepted as the most characteristic indication of the constant admixture of fresh water; and three of these seven localities, notwithstanding their marine affinities, answer in every particular to this test. In four of them *Quinqueloculina fusca* gives place to stronger marine species; and in one, *Trochammina inflata* is replaced by *Lituola canariensis*. On the other hand, the series presents a large number

of additional species, which may be regarded as "semi-brackish"—in other words, such as will tolerate in a limited degree brackish conditions, whilst normally marine in their habit. The most conspicuous of these belong to the genera *Lagena* (of which almost every British variety occurs), *Bulimina*, *Bolivina*, *Discorbina*, *Truncatulina*, and *Patellina*. Reference to the Table will extend the category, and show the particular forms which occur.

A second series would comprise those areas which are further removed from marine influence, either by greater distance from the coast-line or other circumstances of position. This would include the gatherings made higher up river-estuaries, the "salt grass" of estuarian marshes, and the pools of swampy ground only covered by the sea at exceptionally high tides. Such situations are represented by thirteen columns, viz.:—A, River Clyde; F, River Coquet, at Warkworth Hermitage; 1, River Tay, at Errol; 3, Seaton Sluice; 4, Jarrow Slake; 5, River Wear at Hylton Dene; 6, Hartlepool Slake; 7, River Tees, near Middlesborough; 8, River Exe, near Lympston, and the four Western Scottish gatherings, 10, 11, 12, and 13. Situations of this sort are characterized by the presence generally of the five species before named, with the occasional addition of certain other forms—notably *Quinqueloculina seminulum*, *Q. subrotunda*, *Lituola canariensis*, and *Truncatulina lobatula*.

A third series would embrace the Fen localities, which, zoologically as well as geographically, stand by themselves, the fauna consisting, as already stated, of the species which have survived the gradual change in the surface-contour of that district.

Testaceous Rhizopoda of the *lower* types are often so perishable in their nature that the investments of many are destroyed or their characters obliterated by the mere process of washing and drying the muddy material in which they live. As most of the examinations were necessarily made on material so treated, there is little to offer with respect to the organisms standing immediately lower in the scale; but as their relation to the Foraminifera is very intimate, a mere enumeration of those which have been noticed and the localities in which they were taken will tend to general completeness. This unfortunately cannot be extended beyond the *Difflugiæ*. Dr. Wallich's excellent plate (Ann. & Mag. Nat. Hist. ser. 3. vol. xiii. pl. 16, March 1864) will be a convenient basis of reference.

The typical *Difflugia pyriformis* of Carter (Ann. vol. xiii. pl. 1. fig. 1, Jan. 1864; Wallich, *loc. cit.* figs. 9, 10) is by far the commonest form. It was found in the Coquet, the Wans-

beck, the Tay, the dykes on the site of Whittlesea Mere, the river Cam at Ely, in Barton Broad, Ormesby Broad, Somerton Broad, Horsey Mere, and Hickling Broad. In Ormesby Broad it was the only Rhizopod discovered, no Foraminifera being present in the gathering.

Difflugia mitriformis, the long form (*loc. cit.* fig. 12) was found in the Coquet, the single-horned variety (fig. 7) in the same gathering and in the river Cam at Ely, and the two-horned variety (fig. 8) in the latter locality only.

Difflugia arcella (figs. 34–38) occurred in the river Blyth and in Whittlesea Dykes.

Difflugia globularis (fig. 21), somewhat doubtful specimens in Whittlesea Dykes and in the river Cam at Ely.

One or two specimens of another organism, apparently closely allied to *Difflugia*, were found in Whittlesea Mere. Our friend Mr. H. J. Carter, F.R.S., who has kindly examined the mountings pertaining to this division of the subject, fails to recognize it as a known species. The test is globular, with a narrow, much curved neck, as long as the diameter of the body, rising abruptly from the periphery. In texture it appears to be completely mineralized (calcareous?); the surface is white, and scarcely rougher than is often seen in Foraminifera of some of the normally hyaline genera. In general form it is not altogether unlike Dr. Wallich's figures of *Difflugia spiralis* (*loc. cit.* figs. 24, 24 *a*, 25); but the neck is narrower and longer, and the test, if composite, is built on a different plan, and with much more finely divided materials.

The following is a detailed synopsis of the Foraminifera:—

Cornuspira foliacea, Philippi, sp.

Orbis foliaceus, Philippi (1844), Enum. Moll. Sicil. vol. ii. p. 147, pl. 24. fig. 26.

Very rare. The only satisfactory specimens are from two Northumbrian localities, Budle Bay and the Blyth estuary. A single imperfect shell, obtained from the Montrose Basin, much resembles this species, but may have belonged to an annelid.

Biloculina ringens, Lamarck, sp.

Miliolites ringens, Lamarck (1804), Ann. Mus. vol. v. p. 351, vol. ix. pl. 17. fig. 1.

The "Biloculine" *Miliolæ*, so common in really marine situations at any part of our coast, are comparatively scarce where any admixture of fresh water occurs. The subtype *B. ringens* has been found only in the Montrose Basin, which, as has been pointed out, is one of the least-brackish areas admitted into our Table.

Biloculina elongata, D'Orbigny.

Biloculina elongata, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 298. no. 4.

Estuaries of the Wansbeck and Blyth, and in the river Bure at Yarmouth; in all cases rare.

Biloculina depressa, D'Orbigny.

Biloculina depressa, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 298. no. 1, Modèle no. 91.

The compressed, carinate, feebler form of *Biloculina* occurs sparingly in four out of our five Northumbrian gatherings; elsewhere it has not been met with.

Spiroloculina limbata, D'Orbigny.

Spiroloculina limbata, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 299. no. 9; Soldani, Testaceographia, vol. iii. p. 229, pl. 154. fig. *hh*, and pl. 155. fig. *ii*.

Budle Bay and Blyth; rare.

Triloculina trigonula, Lamarck, sp.

Miliolites trigonula, Lamarck (1804), Ann. Mus. vol. v. p. 351. no. 3; (1822) Anim. s. Vert. vol. vii. p. 612. no. 3.

The "Triloculine" *Miliolæ* found in brackish water belong almost exclusively to the elongate emaciated variety (*T. oblonga*); nevertheless one or two well-grown specimens of the subtype have been met with in Breydon Water, as well as the weaker form.

Triloculina oblonga, Montagu, sp.

Vermiculum oblongum, Montagu (1803), Test. Brit. p. 522, pl. 14. fig. 9.

There is no real boundary-line between *Triloculina* and *Quinqueloculina*; and many specimens assigned to *T. oblonga* might with almost equal reason be placed in the latter genus.

Moderately common in Montrose Basin, the Wansbeck estuary, and Breyden Water; rare in Budle Bay, the Aln, the Bure, and at Westport.

Quinqueloculina seminulum, Linné, sp.

Serpula seminulum, Linné (1767), Syst. Nat. 12th ed. p. 1264. no. 791.

The central type around which the whole of the *Miliolæ* may be grouped, and one of the commonest and most widely distributed, especially in shallow water, is not unfrequent amongst brackish microzoa. Reference to the Table will show that it has been found in the same number of localities as the essentially brackish variety, *Q. fusca*; but in comparative abundance of specimens the latter greatly preponderates. The

examples of *Q. seminulum* from subsaline sources are generally small and thin-shelled; and they show a tendency to run into outspread varieties, such as *Q. subrotunda*.

Quinqueloculina subrotunda, Montagu, sp.

Vermiculum subrotundum, Montagu (1803), Testacea Britannica, p. 521.

Especially common in the Northumbrian gatherings; occurs also in the dykes on the site of Whittlesea Mere and in the river Bure at Yarmouth, but not observed in the "broads" or elsewhere in the fen-waters.

Quinqueloculina Candeiana, D'Orb. Pl. XI. figs. 1 *a*, *b*.

Quinqueloculina Candeiana, D'Orb. (1840), Foram. Cuba, p. 170, pl. 12. figs. 24–26.

A beautiful *Miliola* which was found in the river Cam at Ely resembles the *Quinqueloculina Candeiana* of D'Orbigny more nearly than any other figured species; and though some points of difference may be detected, they are not of sufficient importance to justify varietal separation, at any rate on the basis of a single individual. The Fen specimen is more outspread than D'Orbigny's figure; the margin is expanded into a wide, delicately thin carina, and the exposed edges of the inner chambers are acute. Our friend Prof. Rupert Jones recognizes our figures from their resemblance to a fossil specimen found by him some years ago, and referred provisionally to this species.

Too little importance can hardly be attached to the minute morphological variations of the *Miliolæ*, as specimens pertaining to the group are to be found presenting every possible modification of contour and relation of parts consistent with a certain general plan of growth. The peculiarities of the present specimen, though noteworthy, are quite within what may be regarded as the specific limits of *Quinqueloculina seminulum*.

Quinqueloculina fusca, n. sp. Pl. XI. figs. 2 *a–c*.

Quinqueloculina agglutinans, H. B. Brady (1865), Nat. Hist. Trans. Northumb. and Durham, vol. i. pp. 87, 95.

A very variable Milioline Foraminifer, generally Quinqueloculine in the arrangement of its chambers, but often approaching *Spiroloculina*, on the one hand, in large outspread examples, whilst, on the other, starved individuals are sometimes definitely Triloculine. Its distinctive characters may be stated as under:—

Test composite, only slightly calcareous, usually formed of sand-grains imperfectly cemented upon or imbedded in a

chitinous, almost membranous basis. Colour variable, usually brown. Aperture large and conspicuous, equal in size to the transverse section of the terminal chamber, with which it corresponds in form. Length $\frac{1}{75}$ inch.

In the "Catalogue of the Recent Foraminifera of Northumberland and Durham" (*loc. cit.*) some specimens of this species, found at Hylton Dene, were described as "a feeble variety of *Quinqueloculina*, in which the normal, white, porcellaneous shell is replaced by a composite test composed of arenaceous particles imbedded in a chitinous matrix, with but little calcareous matter;" and they are there referred to *Q. agglutinans*, D'Orb. Subsequent examination of specimens, obtained from many different localities, of the species originally described by D'Orbigny under that name have led to the conviction that the variety so common in brackish water is quite distinct from it.

Q. agglutinans resembles the type *Q. seminulum* in general form, in septation, and with respect to its aperture; it has a large, bold, thick-walled shell, and, so far as our own coast is concerned, is only found in its deeper waters. The surface of the shell is rough; and the constituent sand-grains are of appreciable size, and often prominent. It appears to have a sort of selective power with respect to the material used in the construction of the test, dependent possibly on some physical peculiarity of surface in the sand-grains themselves; for specimens completely soluble in hydrochloric acid have been found in sand containing only a small percentage of calcareous matter. Under any circumstances, acetic or hydrochloric acids completely disintegrate, even when they do not entirely dissolve, the shell.

In contrast to these characters, the present species, *Quinqueloculina fusca*, is very indefinite in form and septation. Our drawing (Pl. XI. figs. 2 *a–c*) represents the appearance of some of the best-developed specimens; but a large proportion of those met with in any brackish gathering run into the feebler Milioline forms, often elongate and narrow, sometimes outspread and thin, according to their tendency towards *Triloculina* on the one hand or *Spiroloculina* on the other. The test itself is always coloured, usually brownish, slightly rough externally, and thin-walled. Its structure has been already alluded to (p. 276). Plate XI. fig. 3 *a* represents a piece of the test mounted in Canada balsam and viewed by transmitted light under a power of 200 diameters; *b* is another portion, decalcified by means of strong acid, and mounted in the same way. These drawings have been made to show to how small

an extent calcareous or earthy constituents are concerned in its formation.

Quinqueloculina fusca is by far the commonest of the brackish *Miliolæ*; and reference to the Table will show how exclusively it affects brackish localities. In the columns devoted to the areas least affected by the influx of fresh water (such as Montrose Basin, Budle Bay, the estuaries of the Blyth, Forth, and Ribble) it is comparatively absent. In those representing the Fen district it is also wanting, except in Hickling Broad and the river Bure. But in the estuarian pools of Northumberland and Durham generally it is quite common, and in the brackish shallows of the lochs on the west of Scotland it is invariably to be found. In the Westport gathering (Clew Bay) it is abundant.

Quinqueloculina secans, D'Orbigny.

Quinqueloculina secans, D'Orb.(1826), Ann. Sci. Nat. vol. vii. p. 303. no. 43, Modèle no. 96.

Rare in brackish water; found with other marine species at Budle Bay, in the Wansbeck, and in the Blyth: one or two specimens also from Hartlepool Slake.

Quinqueloculina bicornis, Walker & Jacob, sp.

Serpula bicornis, Walker & Jacob (*fide* Kanmacher) (1798), Adams's Essays on the Microscope, 2nd ed. p. 633, pl. 14. fig. 2.

Observed only in Budle Bay. It is a common marine species on the Northumberland coast.

Trochammina squamata, Parker & Jones. Pl. XI. fig. 4.

Trochammina squamata, Parker & Jones (1861), Quart. Journ. Geol. Soc. vol. xvi. p. 304. no. 88.

The typical *Trochammina squamata* is almost unknown as a recent British species, one or two specimens from Mr. Jeffreys's Hebrides dredgings in 1866* being the only previous instance of its occurrence in our seas. The shell figured at Pl. XI. fig. 4 was also found in a Hebrides locality (Loch Grunard, Islay), but in brackish water and associated with *Quinqueloculina fusca* and other microzoa of similar habit. It has the characteristic, brown, rough, scale-like test, with irregular surface and very obscure septation. The terminal portion of the spire is somewhat broken, as shown in the figure.

* See "Notes on the Rhizopodal Fauna of the Hebrides," Brit. Assoc. Report, 1866, (Transactions) p. 69.

Trochammina inflata, Montagu, sp.

Nautilus inflatus, Montagu (1808), Suppl. Testacea Britannica, p. 81, pl. 18. fig. 3.

Rotalina inflata, Williamson (1858), Rec. For. Gt. Brit. p. 50, pl. 4. figs. 93, 94.

This species has been carefully studied by Messrs. Parker and Jones from specimens washed out of the clay which underlies the peat in the Fen district near Peterborough. The organic remains contained in this deposit can scarcely be regarded as fossil, as little alteration has taken place in their physical characters, and they represent probably the direct ancestry of the living microzoa of the neighbouring brackish waters. As the distance has increased between the inland fen area and the open sea, and the fen-waters have become in consequence less saline, the present species, amongst others, has grown correspondingly less common, and its distribution limited to a few localities most favourable to its habit.

Trochammina inflata is alike variable in its external contour and appearance and its choice of a habitat. The specimens originally described by Col. Montagu were from the Devonshire coast, Prof. Williamson's from Mr. Barlee's and Mr. Jeffreys's dredgings at various points around the British Isles; but whilst the species is extremely rare in these dredged sands, it is one of those most commonly met with in the mud of shallow lagoons.

The deep-water (marine) specimens in our possession differ somewhat from the brackish type; they are smaller, thicker in proportion, have fewer chambers in each whorl, and show deep constrictions at the septa, especially in the under surface. Specimens with these characters were obtained from depths of fifty fathoms and upwards at two or three points on the west coast of Scotland. We have no record of its occurrence in the coralline or the laminarian zone, though it can scarcely be supposed to cease entirely in intermediate depths.

Professor Williamson's figures (*loc. cit.*) represent excellently what may be regarded as the typical form; and corresponding examples are abundant in brackish pools. There is, however, in addition, an emaciated variety not uncommon in the same localities, diverging from the type in an exactly opposite direction to the deep-water form just alluded to, and presenting about equal morphological affinity to *Trochammina inflata* and *Lituola canariensis*. A recent examination of a very large number of Lituoline Foraminifera from various localities and depths of water on the western shores of Scotland afforded the clearest evidence that no truly specific, still less generic, distinction could be drawn between *Valvulina* (*V. co-*

nica and *V. austriaca*), *Trochammina* (*T. squamata* and *T. inflata*), and *Lituola* (*L. canariensis*). The series of arenaceous Foraminifera so brought together runs through the whole of the "species" named above in parentheses, and is without a break; indeed it may be said that any decision as to the naming of many of the specimens is purely arbitrary. It may be admitted that *Valvulina* has normally only three chambers in each whorl, and that fine specimens sometimes show a perforate primary shell *, that many *Trochamminæ* have tests in which the calcareous cement is largely in excess of the imbedded sand-grains, and that *Lituola* in its finer developments has a coarse, rough, sandy investment; but the series adverted to yields specimens with complete admixture of these supposed generic characters †. Pending the rearrangement of the group, it has been thought best to give a sort of varietal distinction to the complanate specimens above mentioned; and a separate line is accorded to them, under the name *Tr. macrescens*, in the Table.

Little need be added to the particulars contained in the Table respecting the distribution of *Tr. inflata*. It has been found in about one half of the localities searched; but, in the inland Fen area, living specimens have only been noted at a few points.

Trochammina inflata, var. *macrescens*. Pl. XI. figs. 5 *a–c*.

Characters.—Test nautiloid, complanate. Chambers numerous, thin, concave. Septal plane narrow. Texture mem-

* Occasional specimens belonging to the genus *Involutina*, another subarenaceous type scarcely separable from *Trochammina*, but limited in its distribution, so far as at present known, to rocks of the Carboniferous and Liassic periods, show this same character (unusual to the *Lituolida*), a perforated primary shell-wall. See Geol. Mag. November 1864, pl. 9. fig. 6.

† Whilst on the subject of the present arrangement of the arenaceous Foraminifera, I may hazard the view that *Lituola canariensis* is in far closer relationship with the *Trochammina* series than with either *Lituola nautiloidea* or *L. scorpiurus*. There is considerable distinction, again, between these two latter "species." Lamarck's typical form (*L. nautiloidea*), the Hebrides variety of which Professor Williamson figures well as *Proteonina pseudospiralis* (Rec. For. Gt. Br. pl. 1. figs. 2, 3), differs as much in texture and surface and in the character and deposition of its "cement" from *L. scorpiurus* as it does in external form; and as this is equally true when the two occur together in considerable numbers in the same handful of sand, their diverse characters can scarcely be the result of external conditions.

It would be premature to make any material alteration in nomenclature until the result of Dr. Carpenter's researches on the larger arenaceous Rhizopoda obtained in the recent deep-sea explorations are made public. The subject is beyond the scope of the present paper.—H. B. B.

branous, subarenaceous, scarcely calcareous. Colour brown. Long diameter $\frac{1}{65}$ inch.

That the thin outspread nautiloid *Trochamminæ* which abound in some localities are the result of depauperating external influences, possibly extended through very many generations, is most probable, the only alternative supposition being that they are passage forms between the chitinous and arenaceous groups of Rhizopoda. Accepting the former view, the difficulty remains whether the complanate specimens approximate most nearly to *Lituola canariensis* or *Trochammina inflata*, if, indeed, these two are not the same species. The preference for associating them with *Tr. inflata* is founded rather on the extreme tenuity of the test, its membranous nature, and its agreement in chemical relations, than on morphological peculiarities. Supposing the connexion with *Tr. inflata* to be such as has been indicated, there is a manifest convenience in distinguishing the variety by name in the same way as the starved conditions of other genera are recognized. The chemical characters of the test have been before described. The concavity of the individual chambers is due in great degree to the falling-in of the walls from the contraction of the sarcode in drying; but in some specimens with thin square edge, and having a general contour not unlike limbate *Operculinæ*, appearances are against the supposition that the segments ever were convex.

Lituola scorpiurus, Montfort, sp.

Reophax scorpiurus, Montfort (1808), Conchyl. Syst. vol. i. p. 330, 83e genre.

A single specimen only, and that of the stunted form with obscure septation which alone appears on the east coast. It was found in the scarcely brackish material from the Forth.

Lituola canariensis, D'Orbigny, sp.

Nonionina canariensis, D'Orbigny (1839), Nat. Hist. Canaries, p. 128, pl. 2. figs. 33, 34.

Not uncommon in the more marine localities; in the areas most influenced by the influx of fresh water it often gives place to *Trochammina macrescens*.

Lagena sulcata, Walker & Jacob.

Serpula (*Lagena*) *sulcata*. Walker & Jacob (*fide* Kanmacher) (1794), Adams's Essays on the Microscope, 2nd ed. p. 634, pl. 14. fig. 5.

This, the typical form of *Lagena*, is also the commonest in brackish water. Its absence is conspicuous in the estuarian pools of the Tay, Tyne, Wear, Tees, and Exe, and in

the five western Scottish localities contained in our Table, but through the remainder of the list it is pretty evenly distributed.

Lagena Lyellii, Seguenza, sp. Pl. XI. fig. 7.

Amphorina Lyellii, Seguenza (1862), Foram. Monotal. Mioc. Messin. p. 52, pl. 1. fig. 40.
—— *costata*, id. ibid. p. 52, pl. 1. fig. 41.

It may be fairly questioned whether it is worth while to separate *Lagena Lyellii* from its direct type *L. sulcata*. Regarding it as the distomatous variety of the latter species, its distinctive characters are of the same value as those of *L. distoma* and *L. gracillima*; and the same rule as to recognition should be observed in respect to all three. In addition, however, to the second or basal neck and orifice, all the specimens of *Lagena Lyellii* we have met with possess a second mark of peculiarity in the exogenous spirally arranged deposit of shell-substance investing the superior neck. The supplementary or basal neck commences abruptly from the centre of the lower end of the shell, and is sometimes curved or obliquely set. In the other distomatous forms alluded to the shell tapers towards the lower as towards the upper orifice, although generally more rapidly.

This variety was one of the numerous interesting *Lagenæ* found in the deep-water sands dredged by Mr. Jeffreys in 1866 amongst the Western Isles *. The particular localities were "the Minch," "off Skye," and "Loch Eriboll;" and in every case it was very rare. It is singular that the deep-water shells should have in some instances the same irregular, apparently distorted lip that our brackish specimens both present (see figure).

But two brackish-water examples have occurred in these examinations—one from the Frith of Forth (Bo'ness), the other from the Montrose Basin.

Lagena lævis, Montagu, sp.

Vermiculum læve, Montagu (1803), Testacea Britannica, p. 524.

Distribution almost exactly corresponds with that of *L. sulcata*, but it is not quite so common.

Lagena gracillima, Seguenza, sp. Pl. XI. figs. 6 *a–c*.

Amphorina gracillima, Seguenza (1862), Foram. Monotal. Mioc. Messin. p. 51, pl. 1. fig. 35.

Lagena gracillima has scarcely been recognized hitherto as a British recent species, and it is best known as a Tertiary

* British Association Reports, 1866, (Transactions) p. 70.

fossil. It is described and figured in the 'Monograph of the Crag Foraminifera,' p. 45, pl. 1. figs. 36, 37, where a succinct account of its peculiarities and distribution may be found. It is, morphologically speaking, the distomatous variety of *Lagena lævis*.

Lagena gracillima is frequently met with in Northumbrian estuaries. In the Fen district it has only been noticed at one point, Breydon Water. It also occurs in two localities far apart, but similar in tidal relations, viz. Montrose Basin and Westport, Ireland.

Lagena globosa, Montagu, sp.

Vermiculum globosum, Montagu (1803), Testacea Britannica, p. 523.

Not uncommon in river-estuaries where there is sufficient admixture of sea-water; sparingly found in most of the Fen gatherings.

Lagena striata, D'Orbigny, sp.

Oolina striata, D'Orbigny (1839), Foram. Amér. Mérid. p. 21, pl. 5. fig. 12.

In the Northumbrian estuaries and Montrose Basin; one or two specimens also from the mouth of the Ribble.

Lagena semistriata, Williamson.

Lagena striata, var. *β. semistriata*, Williamson (1848), Ann. & Mag. Nat. Hist. ser. 2. vol. i. p. 14, pl. 1. figs. 9, 10.

Less frequent than *L. striata* in estuaries, but found in some Fen localities, where the latter species has not been observed at all, viz. dykes on the site of Whittlesea Mere, Somerton Broad, and Breydon Water.

Lagena distoma, Parker & Jones.

Lagena sulcata, var. *distoma*, Parker & Jones (1864), Phil. Trans. vol. clv. p. 356, pl. 13. fig. 20.

Somewhat common in the Northumbrian estuaries and in the Montrose Basin.

This is one of the species that seems to have died out of the fen-waters as the proportion of saline constituents has diminished; for it is of frequent occurrence, amongst other scarcely fossilized Foraminifera, in the clay underlying the peat as far inland as Peterboro' (*Parker*).

Lagena marginata, Walker & Jacob, sp.

Serpula (*Lagena*) *marginata*, Walker & Jacob (1784), Test. Min. p. 3, pl. 1. fig. 7.

Found in exactly the same gatherings as *L. distoma*. Con-

fined to the more marine localities of Northumberland and the questionably brackish Montrose Basin.

The obscurely quadrangular, compressed, subvarietal form named by Professor Williamson *Entosolenia marginata*, var. *quadrata* (Rec. For. Gt. Br. p. 11, pl. 1. figs. 27, 28), was observed amongst the Wansbeck and Budle-Bay microzoa.

Another subvarietal form, *Entosolenia marginata*, var. *lucida*, Williamson (Rec. For. Gt. Br. p. 11, pl. 1. figs. 22, 23), was found in three localities, viz. Montrose Basin, Wansbeck, and Frith of Forth.

These two modifications, dependent for their distinction on very trifling morphological peculiarities, are not of sufficient importance to need record in the Table of distribution.

Lagena ornata, Williamson, sp.

Entosolenia marginata, var. *ornata*, Williamson (1858), Rec. For. Gt. Br. p. 11, pl. 1. fig. 24.

A few specimens from Montrose Basin and a still smaller number from Budle Bay are all that have come under our notice. This is altogether a rare form on the British coast, though its distribution is not particularly restricted in a geographical sense, and it has been repeatedly noticed as a Tertiary fossil.

Lagena pulchella, Brady. Pl. XII. figs. 1 *a*, *b*.

Lagena pulchella, H. B. Brady (1866), Brit. Assoc. Reports, (Transactions) p. 70.

In a short notice of the Rhizopodal fauna of the Hebrides (*loc. cit.*) this species was described as follows, but was not figured:—

"Characters as *L. marginata*, W. & J., to which it is closely allied, but differing in having a number of delicate parallel costæ springing from the base and extending into the upper half of the shell, in some specimens nearly to the aperture."

A single example of this curious carinate *Lagena*, differing from the Hebrides specimens only in its larger size and correspondingly exaggerated surface-peculiarities, was found in the mud of the Scheldt near Antwerp. The Scottish specimens resemble *L. marginata* in their general form much more closely than this, and the costæ are more delicate and regular; but these are minor characters of deviation, not requiring separate recognition.

We have no instance of the occurrence of *L. pulchella* in brackish water, except the one specimen above alluded to, though it has been found in a part of the Frith of Forth (in-

side Granton Harbour) that just escapes the range of the present paper. A considerable number of specimens were found in a dredging from Fintry Bay, Cumbrae, in 10 to 12 fathoms.

Lagena squamosa, Montagu, sp.

Vermiculum squamosum, Montagu (1803), Testacea Britannica, p. 526, pl. 14. fig. 2.

Rare in Montrose Basin and the north-eastern estuaries; still rarer in the Fen gatherings; entirely absent from the brackish areas examined on the west of Scotland.

Lagena melo, D'Orbigny, sp.

Oolina melo, D'Orbigny (1847), Foram. Amér. Mérid. p. 20, pl. 5. fig. 9.

Very rare; single specimens from Montrose Basin and the estuaries of the Alne and Blyth. Again one specimen alone amongst the Fen microzoa (Breydon Water).

Glandulina lævigata, D'Orbigny.

Nodosaria (*Glandulina*) *lævigata*, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. No. 1, pl. 10. figs. 1–3.

A solitary example from the Scheldt near Antwerp is the only occurrence of *Glandulina lævigata* in brackish water we have note of.

It is altogether rare as a recent species. Mr. Waller found three or four specimens in deep water off Shetland; and Messrs. Parker and Jones obtained it off the coast of Norway. It is difficult to account for its presence in the Scheldt. The other microzoa (except *Lagena pulchella*) were of the ordinary brackish type, so far as could be judged from the limited number at our command.

Nodosaria scalaris, Batsch, sp.

Nautilus (*Orthoceras*) *scalaris*, Batsch (1791), Conchyl. Seesandes, pl. 2. figs. 4 *a*, *b*.

Montrose Basin, Frith of Forth, Budle Bay, estuary of the Blyth, amongst the most nearly marine of the localities named in the Table; in every case very rare and the specimens small.

Dentalina communis, D'Orbigny.

Nodosaria (*Dentalina*) *communis*, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 254. no. 35.

This species, common everywhere on our coast in really marine localities, does not flourish where the water contains less than its normal proportion of saline ingredients. A few very small examples from Montrose Basin, the Frith of Forth, and the estuary of the Aln constitute our collection from

brackish habitats. It has not been found living in the fen-waters nor in the localities examined in the west of Scotland.

Dentalina guttifera, D'Orbigny. Pl. XII. fig. 2.

Dentalina guttifera, D'Orbigny (1846), For. Foss. Vienne, p. 49, pl. 2. figs. 11–13.

Amongst the numerous *Dentalinæ* with subglobular fusiform chambers that have received specific names at the hands of one author or other, *D. guttifera*, as figured in the 'Vienna Basin' monograph, may be accepted as the best representative. D'Orbigny assigns to it the following specific characters:—"Test elongate, smooth. Chambers seven in number, pyriform, inflated, separated by constrictions so deep that the shell appears like a string of beads. The earliest chamber mucronate."

It is very rare to meet with perfect examples of so fragile a shell; and, under any circumstances, to set down a definite number of chambers as a specific character of a polythalamous Foraminifer is wholly untenable. With this exception, the description agrees with the specimens which have come under our notice. In form, the chambers are usually somewhat longer proportionally than in D'Orbigny's figures, and have their widest diameter somewhat below the centre, the upper portion of each tapering gradually to a capillary stoloniferous tube.

Dentalina guttifera may be regarded as the curved condition of *Nodosaria pyrula*. Although occasional specimens have been met with at other portions of the British coast, no notice of its occurrence has been published heretofore. In the brackish gatherings it has only been noted in two localities—Bo'ness (Frith of Forth) and the Blyth estuary.

Marginulina glabra, D'Orbigny. Pl. XII. figs. 3 *a*, *b*.

Marginulina glabra, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 259. no. 6, Modèle no. 55.

One or two specimens from Montrose Basin only. Chance specimens they might be called; for the species is of rare occurrence on the British coast, even under more favourable conditions. We have examples from deep water off the west of Scotland, but elsewhere on our shores have never met with it.

Cristellaria rotulata, Lamarck, sp.

Lenticulites rotulata, Lamarck (1804), Annales du Muséum, vol. v. p. 188. no. 3.

Not at home in brackish water, one very small example in the Blyth gathering being the only instance of its occurrence.

Cristellaria crepidula, Fichtel & Moll, sp.

Nautilus crepidula, Fichtel & Moll (1803), Testacea Microscopica, p. 107, pl. 19. figs. *g*, *i*.

Very rare; represented only by isolated specimens from the Wansbeck and Blyth respectively.

Polymorphina lactea, Walker & Jacob, sp.

Serpula lactea, Walker & Jacob (*fide* Kanmacher) (1798), Adams's Essays, 2nd ed. p. 634, pl. 24. fig. 4.

The typical form of *Polymorphina* seems to give place to a less compact variety, *P. compressa*, under the deteriorating conditions resulting from the admixture of fresh waters. Of the closely allied *P. communis* and *P. oblonga* the same holds true.

Each of these three species has been collected in two localities; but the occurrence of solitary specimens at a few points widely separated yields only the general indication of rarity.

Polymorphina communis, D'Orbigny.

Polymorphina (*Guttulina*) *communis*, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 226. no. 15, pl. 12. figs. 1–4, Modèle no. 62.

Very rare.

Polymorphina oblonga, Williamson.

Polymorphina lactea, var. *oblonga*, Williamson (1858), Rec. For. Gt. Br. p. 71, pl. 6. figs. 149, 149*a*.

Very rare.

Polymorphina compressa, D'Orbigny.

Polymorphina compressa, D'Orbigny (1846), For. Foss. Vienne, p. 243, pl. 12. figs. 32–34.

The least-rare variety of the genus; yet even *P. compressa* is almost confined to the more marine localities of the Table.

In the Fen gatherings specimens referable to *Polymorphina* are almost completely absent, and but for a solitary instance supplied by the dykes on the site of Whittlesea Mere, Breydon Water would stand alone as a Fen habitat; even here the specimens found have been few and small.

It is worthy of note that the closely allied group *Nodosarina*, which is found in one variety or other at every point on our coast, is, so far as appears, entirely wanting amongst the recent microzoa of the fen-waters.

Uvigerina irregularis, Brady.

Uvigerina irregularis, H. B. Brady (1865), Nat. Hist. Trans. North. & Durham, vol. i. p. 100, pl. 12. fig. 5.

The irregular *Uvigerina* with thin, smooth, porous shell is

extremely rare. It was obtained off Holy Island in 20 to 25 fathoms water, and has been found (fossil) in the Crag of Suffolk. A single specimen from the estuary of the Ribble completes the record of its distribution.

Orbulina universa, D'Orbigny.

Orbulina universa, D'Orbigny (1839), Foram. Cuba, p. 3. no. 1, pl. 1. fig. 1.

A variable species in external characters. Specimens from a greater depth than 50 fathoms are white or greyish yellow, often hyaline, and usually entirely calcareous. Sometimes, though rarely, they are rough externally, and bear a superficial resemblance to the finely arenaceous types. Those found in shallower water are almost invariably of a dark brown colour, and have a peculiar texture not truly arenaceous, yet often scarcely calcareous. It is very difficult to distinguish the brown examples of this species met with in inshore gatherings from the chitinous tests of some of the lower Rhizopoda.

Orbulina universa is at home in the deepest seas; in the coralline, laminarian, or littoral zone only an occasional, apparently chance specimen is to be found. Its occurrence is only noted in one column of the Table ("Budle Bay"); and the specimens from that locality may be set down without cavil as true *Orbulinæ*. But in several other brackish areas spherical tests have been found which almost certainly represent the same type modified still further by the deteriorating influence of shallow water and the deficiency of earthy salts.

Globigerina bulloides, D'Orbigny.

Globigerina bulloides, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 277. no. 1, Modèles nos. 17 and 76.

Like *Orbulina universa*, this is essentially a deep-water species. When first met with in brackish river-pools three or four miles inland, its occurrence was regarded as accidental and an explanation was sought in accordance with this view; but as other localities of similar nature were investigated, specimens, few in number and small in size, but to all appearance living, showed themselves amongst other living microzoa in districts widely apart, rendering it impossible to avoid the conclusion that *Globigerina bulloides* can accommodate itself not only to very shallow water, but to very different conditions, as to specific gravity and proportion of saline matter, from those which exist in its normal habitat*.

* What is here stated does not affect, on one side or the other, the mooted question whether *Globigerina lives* at the bottom of the sea or is exclusively pelagic in habit. Major Owen's researches show clearly that it is an important constituent in the surface-fauna of the mid-ocean; but

Specimens have been found in the rivers Wear and Blyth and in the Montrose Basin, localities pertaining to the first section of the Table. In the Fen area examples have been obtained from the river Nene at Peterboro' and from Somerton Broad. At Westport, in Ireland, and in Portree Harbour, Skye, it appeared in large numbers, a circumstance in some measure accounted for by the comparative proximity of deep sea.

Textularia sagittula, Defrance.

Textularia sagittula, Defrance (1824), Dict. Sci. Nat. xxxii. p. 177, liii. p. 344; De Blainville, Malacologie, p. 370, pl. 5. fig. 5.

Montrose Basin and Westport, Ireland; very rare.

Foraminifera of this genus appear to possess remarkably little power of adapting themselves to brackish water. The typical *Textularia sagittula* is common on our coast, even in very shallow situations, such as the rock-pools of the littoral zone; yet we have only two instances of its occurrence in localities influenced by fresh water. Reference to the Table will show that, excepting in three columns before described as representing localities in which the conditions appear to be more nearly marine than the rest, the entire genus is notably absent. Even in these three gatherings the varieties found were amongst the rarest of the microzoa.

Textularia variabilis, Williamson.

Textularia variabilis, Williamson (1858), Rec. For. Gt. Br. p. 76, figs. 162, 163, 168.

Montrose Basin and river Blyth; very rare.

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this is as far as proof goes. On the other hand, it can hardly be believed that the thick-walled heavy specimens so common at the sea-bottom had power of floating when fully grown. Another argument *per contra* exists in the fact that, whilst *Globigerinæ* are found (not commonly, it is true, but still with some frequency) in the sands of other seas, as, for instance, the German Ocean, we have never, after long experience with the towing-net in search of Entomostraca, met with a single free-swimming specimen, nor have we ever heard of one being so captured on our coast. Again, the evidence in respect to *Globigerina* ought to be equally applicable to the other species taken by Major Owen, yet no one has suggested that *Pulvinulina Menardii*, *P. Micheliniana*, *P. canariensis*, and *P. crassa* are exclusively pelagic species.

That sarcodic animals can live at the greatest depths, is sufficiently proved by the existence of *Bathybius*, which cannot be regarded in any other light than an actually living organism.

These observations are prompted by Mr. Jeffreys's note in No. 121 of the 'Proceedings of the Royal Society,' p. 443.

Textularia globulosa, Ehrenberg. Pl. XII. figs. 4 *a*, *b*.

Textularia globulosa, Ehrenberg (1839), Abhandl. Akad. Berlin (1838), p. 135. no. 60, pl. 4, several figs.

One or two specimens of an uncommon variety of *Textularia* having very globular segments were found in the Westport dredgings. Similar forms, some with more numerous chambers, others with fewer, have been figured by Continental authors. The *T. globulosa* of Ehrenberg (*loc. cit.*) takes precedence for purposes of nomenclature, though his specimens apparently were small and had generally but few chambers. M. Cornuel (Mém. Soc. Géol. France, 2e sér. vol. iii. p. 258, pl. 4. fig. 25) figures a very long attenuated *Textularia* with perfectly spherical chambers under the name of *T. elongata*. The *T. globulifera* of Reuss (Sitzungsb. k. Akad. Wissensch. vol. xl. p. 232, pl. 13. figs. 7, 8) is almost the counterpart of our own figures. The whole of these may very properly be included under one varietal name.

The Westport gathering was peculiar in interesting examples; it yielded *Textularia* and its allies. In addition to those named in the Table, one specimen was found with characters somewhat different from any thing we have met with hitherto. The test was thin and complanate, the periphery not constricted at the sutures, the face presenting numerous very oblique chambers separated by broad lines of clear shell-substance; it was unfortunately broken by the artist before the drawing was completed, a loss the more to be regretted as we had not been able to identify the species from published figures.

Textularia pygmæa, D'Orbigny.

Textularia pygmæa, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 263. no. 13, Modèle no. 7.

Montrose Basin; very rare.

Textularia difformis, Williamson.

Textularia variabilis, var. *difformis*, Williamson (1858), Rec. For. Gt. Br. p. 77, pl. 6. figs. 166, 167.

Montrose Basin; very rare.

Gaudryina pupoides, D'Orbigny. Pl. XII. figs. 5 *a*, *b*.

Gaudryina pupoides, D'Orbigny (1840), Mém. Soc. Géol. France, p. 44, pl. 4. figs. 22–24.

Montrose Basin; very rare, two or three specimens only.

Gaudryina pupoides has not before been found on the British coast; nor is it, under any circumstances, of common occurrence, either in a recent or fossil condition. The brackish

specimens have nearly the same contour as D'Orbigny's *G. pupoides*, the triserial chambers being obscure and constituting but a small proportion of the test; but the texture is as rough as that represented by the same author in his *G. rugosa*, which, however, can scarcely be regarded as a specifically distinct form.

Verneuilina spinulosa, Reuss. Pl. XII. figs. 6 *a–c*.

Verneuilina spinulosa, Reuss (1849), Denkschr. mathem.-natur. Cl. k. Akad. Wissensch. vol. i. p. 374, pl. 47. fig. 12.

Two specimens of this interesting triserial Textularian were found in the Westport dredgings. They are somewhat limbate at the sutures, and the edges are not so sharp as those from Tertiary sources, nor are the marginal spinous processes developed to the same extent; but in other respects their contour answers to Professor Reuss's figures. As *V. spinulosa* had not before been met with in British seas, it was questioned whether these might not be "derived" from fossiliferous beds in the neighbourhood; but there is no evidence in favour of such a supposition. The shells have all the appearance of living specimens, and they were associated with other Protozoa all obviously recent. Neither are there any strata on the shores of Clew Bay of an age at all likely to yield such species. Our good friend and colleague Mr. W. K. Parker has, with his usual kindness, examined these and some other specimens upon which questions might have been raised, and has confirmed the conclusions arrived at with respect to them.

Verneuilina polystropha, Reuss, sp.

Bulimina polystropha, Reuss (1846), Böhm. Kreid. vol. ii. p. 109, pl. 24. fig. 53.

Estuary of the Exe and Loch-in-Daal, Islay; rare.

Bulimina pupoides, D'Orbigny.

Bulimina pupoides, D'Orbigny (1846), For. Foss. Vienne, p. 185, pl. 11. figs. 11, 12.

Very rare; only noted at Westport; and the specimens there found were scarcely distinguishable from large stout examples of *B. ovata*.

Bulimina marginata, D'Orbigny.

Bulimina marginata, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 269, pl. 12. figs. 10–12.

In two or three northern habitats; very rare. Hardly to be considered a brackish species.

Bulimina ovata, D'Orbigny.

Bulimina ovata, D'Orbigny (1846), For. Foss. Vienne, p. 185, pl. 11. figs. 13, 14.

The commonest of the *Buliminæ*, indeed the only variety that accepts the brackish conditions without much deterioration. Its occurrence is confined to the northern localities, which, as before stated, present a fauna resembling that of the littoral and laminarian zones.

Bulimina elegantissima, D'Orbigny.

Bulimina elegantissima, D'Orbigny (1839), Voyage l'Amér. Mérid. p. 51, pl. 12. figs. 13, 14.

From the Montrose Basin and Frith of Forth; very rare.

Virgulina Schreibersii, Czjzek.

Virgulina Schreibersii *, Czjzek (1848), Haidinger's Natur. Abhandl. vol. i. p. 147, pl. 13. figs. 18–21.

Montrose Basin; very rare.

Bolivina punctata, D'Orbigny.

Bolivina punctata, D'Orbigny (1839), Voyage l'Amér. Mérid. p. 63, pl. 8. figs. 10–12 †.

Frequent in the northern estuaries, where the admixture of fresh water is not excessive. Absent from the Durham gatherings and those from the west of Scotland. Has not been found living at any point in the Fen district.

Bolivina plicata, D'Orbigny. Pl. XII. figs. 7 *a*, *b*.

Bolivina plicata, D'Orbigny (1839), Voyage l'Amér. Mérid. p. 62, pl. 8. figs. 4–7.

Distribution similar to that of the foregoing species (*B. punctata*), but rarer; confined to the Montrose Basin, the Frith of Forth, Budle Bay, and the river Blyth.

D'Orbigny, in his 'South America' monograph, describes three varieties of biserial *Buliminæ*, viz. *Bolivina punctata*, *B. plicata*, and *B. costata*. None of these are given in Professor Williamson's work as British species; but the first has been collected at many points of our coast, from Shetland southwards, on both sides of the island; the second (*B. plicata*) is now first recorded from British localities; whilst the

* The specific name is written *Schreibersiana* in the text of Czjzek's memoir, *Schreibersii* on the plate. The latter term is already in common use, and it does not seem worth while to change, though ordinarily the name adopted in the letterpress would take precedence.

† Figured in the Trans. Linn. Soc. vol. xxiv. pl. 48. fig. 9; and Nat. Hist. Trans. N. & D. vol. i. pl. 12. figs. 8, *a*, *b*.

third, though of extreme rarity, has been found by Mr. W. K. Parker in a shallow-water mud at Eastbourne, Sussex.

D'Orbigny's figures of *B. plicata* are, as usual, somewhat diagrammatic, designed from the theoretical morphology of the shell rather than its actual appearance.

Discorbina rosacea, D'Orbigny, sp.

Rotalia rosacea, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 273. no. 15, Modèle no. 39.

Noticed only in two or three of the more nearly marine gatherings in the north; scarcely at home in brackish water.

Discorbina globularis, D'Orbigny, sp.

Rosalina globularis, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 271. no. 1, pl. 13. figs. 1–4, Modèle no. 69.

Frequent in the northern estuaries and in Portree Harbour, but not hitherto observed living at any point in the Fen area.

Planorbulina mediterranensis, D'Orbigny.

Planorbulina mediterranensis, D'Orbigny (1826), Ann. Sci. Nat. vol. vii. p. 280. no. 2, pl. 14. figs. 4–6, Modèle no. 79.

Occurs generally in the Northumbrian estuaries, the Clyde, and Montrose Basin. Found sparingly in the river Bure at Yarmouth and in Breydon Water.

Truncatulina lobatula, Walker & Jacob, sp.

Nautilus lobatulus, Walker & Jacob (1798) (*fide* Kanmacher), Adams's Essays on the Microscope, 2nd. ed. p. 642, pl. 14. fig. 36.

Found in localities pertaining to each of the three divisions of the Table, but especially common in the Northumbrian estuaries. In the Fens it has only been observed in Oulton Broad and the river Bure at Yarmouth.

Truncatulina refulgens, Montfort, sp.

Cibicides refulgens, Montfort (1808), Conchyl. Systém. vol. i. p. 122, 31e genre.

Truncatulina refulgens is the conical variety of the last-named species, usually inhabiting deeper water. It is not common at any part of our coast, even under the conditions it most affects; so that it is not easy to account for its occurrence in Hickling Broad and Horsey Mere, especially in the entire absence of other Rotalian Foraminifera.

Rotalia Beccarii, Linné, sp.

Nautilus Beccarii, Linné (1767), Syst. Nat. 12th ed. p. 1162. no. 276.

Professor Williamson's figures (Rec. For. Gt. Br. pl. iv.

figs. 90–92) represent excellently the typical *Rotalia Beccarii* as it ordinarily occurs both under marine and brackish conditions. In some localities much affected by the influx of fresh water we have found a large proportion of the specimens assuming somewhat modified characters. The peculiarities of these brackish individuals are not of sufficient importance or sufficiently uniform to need even varietal separation as to name, but they are nevertheless of considerable morphological interest. Their divergence from the type is chiefly with respect to the size and general contour of the test, its texture, and the fitting together of the chambers. Our Plate XII. figs. 8 *a–c* represent a fair example, though many could have been chosen showing the peculiarities more strikingly. These shells are usually white and opaque rather than hyaline in texture; the spiral face is less convex than in the type, sometimes quite flat, the inferior side having a corresponding increase of convexity. The septation is much obscured, often scarcely discernible on the spiral face beyond the last-formed circlet of chambers, though more frequently, as in fig. 8 *a*, the division may be traced through a second turn of the spire. The septa are radial rather than, as in the type, very oblique. The diameter seldom exceeds $\frac{1}{40}$ of an inch and is commonly less, whilst that of the type is from $\frac{1}{30}$ to $\frac{1}{25}$ inch. There is often an angular appearance about the periphery of the brackish variety that is not easily conveyed in a drawing, but which, nevertheless, gives to the specimens a somewhat peculiar aspect.

Rotalia Beccarii is one of the most widely distributed of all the brackish Rhizopoda, although the relative number of individuals is not nearly so large as those of the genera *Polystomella* and *Nonionina*. The particulars noted in the Table refer to the distribution of the typical form; the brackish modification of the type above described occurs in the river Bure and in the Tyne (Jarrow Slake), and is the commoner of the two in the estuaries of the Blyth and Exe.

Tinoporus lævis, Parker & Jones, sp.

Orbitolina lævis, Parker & Jones (1860), Ann. & Mag. Nat. Hist. ser. 3. vol. vi. p. 33. no. 7.

Only a single specimen of *Tinoporus lævis*, and that a somewhat worn and obscure one, has been noticed in the course of these examinations. It was found in the Bo'ness gathering (Frith of Forth), and is probably a dead shell accidentally carried in by the tide from deeper sea. Under these circumstances it has been omitted from the catalogue, pending better evidence of its power of living in brackish water.

Patellina corrugata, Williamson.

Patellina corrugata, Williamson (1858), Rec. For. Gt. Br. p. 47, pl. 3. figs. 86–88.

A considerable number of small specimens of this interesting type occurred amongst the microzoa from Montrose Basin, and a few in the Blyth estuary; elsewhere it has not been noticed in brackish water. Hitherto *Patellina corrugata* has been regarded as a deep-water species, and has been rarely met with on the east coast.

Polystomella striatopunctata, Fichtel & Moll, sp.

Nautilus striatopunctatus, Fichtel & Moll (1803), Testacea Microscopica, p. 61, pl. 9. figs. *a–c*.

The commonest of all Foraminifera inhabiting brackish water. In the Fen district its distribution is curiously irregular, following that of *Rotalia Beccarii* very closely. In two of the western Scottish localities it has not been observed, possibly owing to insufficient quantity of material; but with these exceptions it has been invariably and abundantly present even in the areas furthest removed from the open sea. As before stated, specimens, apparently living, were found in one locality where the water was absolutely fresh; and it existed plentifully in a pool near the river Wear, in which analysis showed only one per cent. of saline constituents. In such cases the shell-wall is exceedingly thin and transparent, and the shells are often of a pale green colour, but otherwise have characters identical with those of marine origin. The entire absence of the type (*P. crispa*), so common almost everywhere in marine gatherings from our shores, is worthy of note. There is but little doubt that the present form is only the depauperated condition of the more robust typical species.

Nonionina asterizans, Fichtel & Moll, sp.

Nautilus asterizans, Fichtel & Moll (1803), Testacea Microscopica, p. 37, pl. 3. figs. *e–h*.

In the estuaries of the Alne, Blyth, Tees, and Scheldt; very rare.

The typical *N. asterizans* is scarcely distinguishable from fine specimens of *N. depressula*, except by the slight deposit of clear shell-substance radiating from the umbilicus. Morphologically it lies between *N. depressula* and *N. stelligera*, the latter having an extreme development of the stellate sutural limbation. Both *N. asterizans* and *N. stelligera* are very rare in the British seas.

Nonionina turgida, Williamson, sp.

Rotalina turgida, Williamson (1858), Rec. For. Gt. Br. p. 50, pl. 4. figs. 95–97.

Montrose Basin; very rare.

A single shell of the still more inflated variety *Nonionina scapha* occurred in the material from the estuary of the Ribble; but it appeared to be a dead specimen, and it has therefore been omitted from the catalogue.

Nonionina depressula, Walker & Jacob, sp.

Nautilus depressulus, Walker & Jacob (*fide* Kanmacher) (1798), Adams's Essays, 2nd ed. p. 641, pl. 14. fig. 33.

The remarks appended to *Polystomella striatopunctata* relative to distribution apply with almost equal force to this species. It is almost invariably abundant in brackish pools.

Notes.

1. In the following Table an attempt is made to show the relative frequency of the various species of Foraminifera on the same plan as that previously adopted with respect to the Entomostraca,—*three* asterisks being placed to the commonest forms, *two* to those occurring frequently but not in any considerable number, and one to those of extreme rarity. In most of the columns these marks indicate with tolerable accuracy the relative distribution of the species; but in a few, either from insufficiency of material or other circumstance, the record must be taken with reservation. The columns headed 9, 11, and 12 (River Ribble, Loch Grunard, and Portree Harbour) are of this category; and that marked D *d* (Scheldt) is not given as in any sense an exhaustive catalogue, but only as a note of the specimens placed in our hands by Mr. E. C. Davison.

2. Column 15, the summary of Mr. Parker's subrecent gatherings from the Fen clay, requires the addition of the following species to make it complete. As none of them have been found living in any of the localities treated of in the present paper, it was thought needless to extend the Table by their insertion:—

Lituola agglutinans, *D'Orb.* *	Uvigerina aculeata, *D'Orb.* *
Spirillina vivipara, *Ehrenb.* *	Virgulina squamosa, *D'Orb.* *
Lagena caudata, *D'Orb.* **	Pulvinulina Karsteni, *Reuss.* **
Nodosaria raphanus, *Linn.* *	Nonionina umbilicatula, *Montag.* *
—— aculeata, *D'Orb.* *	—— granosa, *D'Orb.* **

[*To face* p. 306.

Subkingdom PROTOZOA.

Class **RHIZOPODA.**

Order RETICULARIA.

(FORAMINIFERA.)

Types.	Genera and Species.	Clyde. A.	Montrose Basin. B.	Budle Bay. C.	R. Aln (above Alnmouth). E.	R. Coquet (Warkworth Hermitage). F.	R. Wansbeck. G.	R. Blyth. H.	R. Tay (Errol). 1.	Frith of Forth (Bo'ness). 2.	Seaton Sluice. 3.	R. Tyne (Jarrow Slake). 4.	R. Wear (Hylton Dene). 5.	Hartlepool Slake. 6.	R. Tees (near Middlesbro'). 7.	R. Exe (Lympston). 8.	R. Ribble. 9.	Dykes on the Site of Whittlesea Mere. O.	R. Nene (Peterboro'). Q.	R. Cam (Ely). R.	Wroxham Broad. S.	Barton Broad. T.	Hickling Broad and Horsey Mere. U,V.	Somerton Broad. W.	Oulton Broad. Y.	R. Bure (Yarmouth.) Aa.	Breydon Water. Bb.	R. Scheldt (near Antwerp). Dd.	Loch-in-Daal (Islay). 10.	Loch Grunard (Islay). 11.	Portree Harbour (Skye). 12.	Loch Gilp. 13.	Westport (Ireland). 14.	Summary of Mr. Parker's subrecent Pendlay gatherings (see page 306). 15.
Suborder IMPERFORATA.																																		
Family Miliolida.																																		
Cornuspira foliacea, *Phil.*	Cornuspira, *Schultze.* foliacea, *Philippi*	...	*	*	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**
Miliola seminulum, *Linn.*	Biloculina, *D'Orb.* ringens, *Lamk.*	...	*																														
	depressa, *D'Orb.*	...	...	*	*	...	*	*																									
	elongata, *D'Orb.*	...	...	...	...	...	*	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*							
	Triloculina, *D'Orb.* trigonula, *Lamk.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*						
	oblonga, *Montagu*	...	**	*	*	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	**	...	...	...	...	*	**
	Quinqueloculina, *D'Orb.* seminulum, *Linn.*	...	*	**	**	...	**	***	...	*	...	...	...	*	**	...	...	...	...	...	...	*	...	...	...	**	*	*	...	...	*	...	**	
	Candeiana, *D'Orb.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	
	subrotunda, *Montagu*	...	*	**	**	...	*	***	...	***	...	...	...	...	**	...	...	**	...	...	...	...	...	...	...	**	...	...	...	...	...	...	**
	secans, *D'Orb.*	...	...	*	...	...	*	*	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	**						
	bicornis, *W. & J.*	...	...	*																													
	fusca, *nov. spec.*	**	...	...	**	**	**	...	...	...	***	...	***	...	*	...	...	...	...	...	...	...	...	***	...	...	*	...	...	***	***	*	***	***	
	Spiroloculina, *D'Orb.* limbata, *D'Orb.*	...	...	*	...	...	...	*																									
Family Lituolida.																																		
Trochammina squamata, *P. & J.*	Trochammina, *P. & J.* squamata, *P. & J.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*			
	inflata, *Montagu*	...	**	*	**	...	**	**	...	...	*	...	**	...	**	...	...	*	...	...	...	...	**	...	...	**	**	...	**	...	...	*	*	**
	macrescens, *nov. spec.*	...	...	...	...	...	...	*	...	...	...	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**	...	**	**	
Lituola nautiloidea, *Lamk.*	Lituola, *Lamk.* scorpiurus, *Montfort*	...	...	...	...	...	...	...	...	*																							
	canariensis, *D'Orb.*	**	...	*	**	...	*	*	**	**	*	...	...	...	...	...	...	...	...	...	...	...	**	**	...	...	**	...	...	**	*	**	**	**
Suborder PERFORATA.																																		
Family Lagenida.																																		
Lagena sulcata, *W. & J.*	Lagena, *Walker.* sulcata, *W. & J.*	...	**	***	**	*	**	***	...	**	...	...	...	...	...	...	*	...	...	...	...	...	...	**	*	*	**	...	...	...	...	...	*	**
	Lyellii, *Seguenza*	...	*	...	...	...	...	...	...	*																							
	lævis, *Montagu*	...	***	***	**	...	*	*	...	***	...	...	...	...	...	...	*	*	...	...	...	...	...	*	...	**	**	..	...	...	...	...	*	**
	gracillima, *Seguenza*	...	**	**	**	...	*	**	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	**	**
	globosa, *Montagu*	...	*	*	?	...	*	*	...	**	...	...	...	...	...	...	*	...	...	*	*	...	...	*	**	*	...	...	...	...	...	...	*	**
	striata, *D'Orb.*	...	**	**	**	...	*	**	...	**	...	...	...	...	...	...	*																	
	semistriata, *Will.*	...	*	**	*	...	*	**	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	**	...	...	*	...	...	...	...	...	*	***
	distoma, *P. & J.*	...	**	**	**	...	*	*	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**
	marginata, *W. & J.*	...	**	**	*	...	**	**	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**
	ornata, *Will.*	...	**	*																														
	pulchella, *Brady*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*					
	squamosa, *Montagu*	...	*	*	...	...	*	**	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	**
	melo, *D'Orb.*	...	*	...	*	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	....	...	...	...	...	...	**
Nodosarina raphanus, *Linn.*	Glandulina, *D'Orb.* lævigata, *D'Orb.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*					
	Nodosaria, *Lamk.* scalaris, *Batsch.*	...	*	*	...	...	...	*	...	*																							
	Dentalina, *D'Orb.* communis, *D'Orb.*	...	*	...	*	...	...	...	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*
	guttifera, *D'Orb.*	...	...	...	...	...	...	*	...	*																							
	Vaginulina, *D'Orb.* legumen, *Linn.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	
	Marginulina, *D'Orb.* glabra, *D'Orb.*	...	*																														
	Cristellaria, *Lamk.* rotulata, *Lamk.*	...	...	...	...	...	...	*																									
	crepidula, *F. & M.*	...	...	...	...	...	*	*																									
Polymorphina lactea, *W. & J.*	Polymorphina, *D'Orb.* lactea, *W. & J.*	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**
	communis, *D'Orb.*	...	...	...	*	...	...	*																									
	oblonga, *Will.*	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*						
	compressa, *D'Orb.*	...	**	**	...	...	**	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**						
Uvigerina pygmæa, *D'Orb.*	Uvigerina, *D'Orb.* irregularis, *Brady*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*																
Family Globigerinida.																																		
Orbulina universa, *D'Orb.*	Orbulina, *D'Orb.* universa, *D'Orb.*	...	...	*																													
Globigerina bulloides, *D'Orb.*	Globigerina, *D'Orb.* bulloides, *D'Orb.*	...	*	...	...	...	...	*	...	...	...	...	*	...	...	...	...	...	...	*	...	...	...	*	...	...	...	...	...	...	*	...	**	**
Textularia agglutinans, *D'Orb.*	Textularia, *Defrance.* sagittula, *Defrance*	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	
	variabilis, *Will.*	...	*	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	***
	globulosa, *Ehrenb.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	
	pygmæa, *D'Orb.*	...	*																														
	difformis, *Will.*	...	*																														
	Gaudryina, *D'Orb.* pupoides, *D'Orb.*	...	*																														
	Verneuilina, *D'Orb.* spinulosa, *Reuss*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	
	polystropha, *Reuss*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	*					
Bulimina Presli, *Reuss*	Bulimina, *D'Orb.* pupoides, *D'Orb.*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	
	marginata, *D'Orb.*	...	*	...	...	...	...	*	...	*																							
	ovata, *D'Orb.*	...	**	***	**	...	**	*	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	...	...	...	**	
	elegantissima, *D'Orb.*	...	*	...	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**
	Virgulina, *D'Orb.* Schreibersii, *Czjzek*	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**
	Bolivina, *D'Orb.* punctata, *D'Orb.*	...	*	**	*	...	**	*	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*
	plicata, *D'Orb.*	...	*	*	...	...	...	*	...	*																							
Discorbina turbo, *D'Orb.*	Discorbina, *P. & J.* rosacea, *D'Orb.*	...	*	*	...	...	**	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*
	globularis, *D'Orb.*	...	...	*	*	...	**	**	**	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	**	...	*
Planorbulina farcta, *F. & M.*	Planorbulina, *D'Orb.* mediterranensis, *D'Orb.*	**	*	**	**	...	*	**	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*	*	...	...	...	*	...	*	**
	Truncatulina, *D'Orb.* lobatula, *Walker*	...	*	*	**	...	**	***	...	**	...	*	...	**	*	...	...	...	...	...	...	...	...	...	...	*	*	...	...	...	...	...	...	*
	refulgens, *Montfort*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*											
Pulvinulina repanda, *F. & M.*	Pulvinulina, *P. & J.* auricula, *F. & M.*	...	...	*																													
Rotalia Beccarii, *Linn.*	Rotalia, *Lamk.* Beccarii, *Linn.*	...	*	**	**	**	*	**	...	**	**	**	...	*	**	***	**	*	...	*	...	...	...	...	**	***	***	*	...	...	...	...	***	***
Patellina concava, *Lamk.*	Patellina, *Will.* corrugata, *Will.*	...	**	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*
Family Nummulinida.																																		
Polystomella crispa, *Linn.*	Polystomella, *Lamk.* striato-punctata, *F. & M.*	**	***	**	***	***	***	***	**	***	***	***	***	***	***	***	***	**	...	...	...	**	...	...	*	***	***	**	***	...	**	...	***	***
	Nonionina, *D'Orb.* asterizans, *F. & M.*	...	...	...	*	...	...	*	...	...	...	...	...	...	*	...	...	...	...	...	...	...	...	...	...	...	...	*	...	...	...	...	...	***
	turgida, *Will.*	...	*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	*
	depressula, *W. & J.*	**	*	**	*	**	**	***	**	**	***	**	...	***	***	**	*	**	...	**	*	...	...	*	**	**	***	...	...	...	**	...	**	***

EXPLANATION OF PLATES IV.–XII.

Plate IV.

Fig. 1. *Cypris ventricosa* (female ?), seen from the left side.
Fig. 2. The same, seen from below.
Fig. 3. The same, seen from behind.
Fig. 4. *Cypris tumefacta* (female ?), seen from the left side.
Fig. 5. The same, seen from above.
Fig. 6. The same, seen from the front.
Fig. 7. *Cypris fretensis* (female ?), seen from the left side.
Fig. 8. The same, seen from below.
Fig. 9. The same, seen from behind.

Plate V.

Fig. 1. *Candona diaphana* (male ?), seen from the left side.
Fig. 2. The same, seen from above.
Fig. 3. The same, seen from below.
Fig. 4. *Candona hyalina* (male), superior antenna.
Fig. 5. The same, inferior antenna.
Fig. 6. The same, mandible and palp.
Fig. 7. The same, palp of second jaw (female).
Fig. 8. The same, second jaw and palp (male). ×84.
Fig. 9. The same, postabdominal ramus. ×120.
Fig. 10. The same, glandula mucosa (male). ×210.
Fig. 11. The same, copulative organs (male). ×84.

Plate VI.

Fig. 1. *Metacypris cordata* (female ?), seen from the left side.
Fig. 2. The same, seen from above.
Fig. 3. The same, seen from below.
Fig. 4. The same, seen from the front.
Fig. 5. The same, right valve, from inside.
Fig. 6. The same, left valve, from inside.
Fig. 7 *a*. The same, right valve, superior margin, seen from above.
Fig. 7 *b*. The same left valve, " " "
Fig. 8 *a*. The same, left valve, inferior margin, seen from below.
Fig. 8 *b*. The same, right valve, " " "
Fig. 9 *a*. The same, right valve, posterior margin, seen from behind.
Fig. 9 *b*. The same, left valve, " " " "

Plate VII.

Fig. 1. *Polycheles Stevensoni* (female), seen from the left side.
Fig. 2. The same, seen from above.
Fig. 3. The same, seen from below.
Fig. 4. The same, seen from the front.
Fig. 5. The same (male ?), seen from the left side.
Fig. 6. The same, seen from above.
Fig. 7. The same, lucid spots. ×100.
Fig. 8. *Candona compressa* (female), seen from above.
Fig. 9. The same, seen from the right side.
Fig. 10. *Goniocypris mitra*, seen from the left side.
Fig. 11. The same, seen from above.
Fig. 12. The same, seen from below.
Fig. 13. The same, seen from the front.

Fig. 14. *Cypridopsis Newtoni* (female), seen from the left side.
Fig. 15. The same, seen from above.
Fig. 16. The same, seen from the front. } ×40.

Plate VIII.

Fig. 1. *Loxoconcha pusilla*, seen from the left side.
Fig. 2. The same, seen from above.
Fig. 3. The same, seen from the front.
Fig. 4. *Argillœcia aurea*, seen from left side.
Fig. 5. The same, seen from below. } ×84.
Fig. 6. *Cytheridea torosa* (male), seen from the left side. } ×40.
Fig. 7. The same, seen from above.
Fig. 8. *Cythere fidicula*, seen from the left side.
Fig. 9. The same, seen from above.
Fig. 10. The same, seen from below.
Fig. 11. The same, seen from the front. } ×84.

Plate IX.

Fig. 1. *Cytheridea inæqualis*, seen from the right side.
Fig. 2. The same, seen from above.
Fig. 3. The same, seen from below.
Fig. 4. The same, seen from the front. } ×40.
Fig. 5. *Candona hyalina* (male), seen from the left side. } ×30.
Fig. 6. The same, seen from above.
Fig. 7. The same (female), seen from the left side.
Fig. 8. The same, seen from above.
Fig. 9. *Candona Kingsleii* (male), seen from the left side.
Fig. 10. The same, seen from above.
Fig. 11. *Candona Kingsleii* (female), seen from the left side.
Fig. 12. The same, seen from above.
Fig. 13. *Candona candida*, var. *tumida* (female), seen from the right side.
Fig. 14. The same, seen from above.
Fig. 15. The same, seen from behind. } ×40.

Plate X.

Fig. 1. *Cytherura propinqua*, seen from the left side.
Fig. 2. The same, seen from above.
Fig. 3. *Loxoconcha fragilis*, left valve, seen from outside. } ×84.
Fig. 4. *Polycheles Stevensoni* (female), superior antenna.
Fig. 5. The same, inferior antenna.
Fig. 6. The same, mandible.
Fig. 7. The same, first maxilla.
Fig. 8. The same, second maxilla.
Fig. 9. The same, first foot.
Fig. 10. The same, second foot.
Fig. 11. The same, third foot.
Fig. 12. The same, abdominal ramus.
Fig. 13. The same, copulative organs of male.
Fig. 14. The same, infero-posteal angle of shell, with jointed hairs. } ×210.

PLATE XI.

Fig. 1. *Quinqueloculina Candeiana*, D'Orb., × 95 diams.: *a*, lateral aspect; *b*, end view, showing the aperture.
Fig. 2. *Quinqueloculina fusca*, n. sp., × 95 diams.: *a* & *c*, lateral aspects; *b*, end view, showing aperture.
Fig. 3. Portions of the test of the same, more highly magnified, × 200 diams.: *a*, portion of the test mounted in Canada balsam and viewed by transmitted light; *b*, similar fragment decalcified by means of strong acid before mounting, the chitinous matrix alone remaining.
Fig. 4. *Trochammina squamata*, P. & J., × 40 diams.
Fig. 5. *Trochammina inflata*, var. *macrescens*, × 90 diams.: *a* & *c*, lateral aspects; *b*, peripheral aspect, showing aperture.
Fig. 6. *Lagena gracillima*, Seguenza, × 100 diams.: *a* & *c*, lateral views; *b*, end view, showing one of the apertures.
Fig. 7. *Lagena Lyellii*, Seguenza, × 95 diams.

PLATE XII.

Fig. 1. *Lagena pulchella*, Brady, × 65 diams.: *a*, lateral aspect; *b*, end view, showing aperture.
Fig. 2. *Dentalina guttifera*, D'Orb., × 115 diams.
Fig. 3. *Marginulina glabra*, D'Orb., × 115 diams.
Fig. 4. *Textularia globulosa*, Ehrenberg, ×115 diams.: *a*, lateral aspect; *b*, end ditto.
Fig. 5. *Gaudryina pupoides*, D'Orb., × 115 diams.: *a*, lateral aspect; *b*, end ditto.
Fig. 6. *Verneuilina spinulosa*, Reuss, × 95 diams.: *a*, view of one of the three faces; *b*, general lateral aspect perpendicular to one of the carinæ; *c*, end view, showing the aperture.
Fig. 7. *Bolivina plicata*, D'Orbig., × 95 diams.: *a*, lateral aspect; *b*, end view and aperture.
Fig. 8. *Rotalia Beccarii*, Linn., brackish variety, × 55 diams.: *a* & *b*, superior and inferior lateral aspects; *c*, peripheral aspect.

XXVII.—*Notes on Anchoring Sponges* (*in a Letter to* Mr. Moore). By Dr. J. E. GRAY, F.R.S. &c.*

MY DEAR MOORE,

Mrs. Gray, who was very much pleased with the additions to and alterations of the Museum, since she saw it five years ago, has not been unmindful of the wish you expressed to have a specimen of the globular anchor-sponge, from the coast of Portugal, which Mr. Kent has named *Pheronema Grayi*, to exhibit during the meeting of the British Association.

On speaking to Mr. Kent, he placed a specimen at Mrs. Gray's disposal for the purpose you wished. As the specimen, like all the others brought home from Portugal, and like those of *Holtenia Carpenteri* from the North Sea, had the

* Read at the Biological Section of the British Association, Sept. 1870.